BAHIR DAR UNIVERSITY

COLLEGE OF AGRICUTLURE AND ENVIRONMENTAL SCIENCES DEPARTMENT

OF ANIMAL PRODUCTION

ON FARM EVALUATION OF *ZIZIPHUS- SPINACHRISTI LEAVE* SUPPLEMENTATION ON FEED INTAKE AND BODY WEIGHT CHANGE OF LOCAL GOAT BREEDS IN KALLU DISTRICT, SOUTH WOLLO ZONE, AMHARA REGION

M.Sc. Thesis

BY

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THESIS APPROVAL SHEET

As member of the Board of Examiners of the Master of Sciences (M.Sc.) thesis open defense examination, we have read and evaluated this thesis prepared by **Ansha Ali** entitled"**On Farm Evaluation of *Ziziphus-spinachristi* Leaf Supplementation on Feed Intake and Body Weight Change of Local Goat Breeds in Kallu District, South Wollo Zone, Amhara Region**".We hereby certify that, the thesis is accepted for fulfilling the requirements for the awardof the degree of Master of Sciences (M.Sc.) in Animal production

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DECLARATION

This is to certify that this thesis entitled "On Farm Evaluation of Feed Intake and Body Weight Change of Local Breed Goats Supplemented with Different Level of *Ziziphus-spinachristi* Leaves in Kallu District, South Wollo Zone, Amhara Region" submitted in partial fulfillment of the requirements for the award of the degree of Master of Science to the Graduate Program of College of Agriculture and Environmental Sciences, Bahir Dar University by Miss Ansha Ali (ID. No.0602075) is an authentic work carried out by her under our guidance. The matter embodied in this project work has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

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BIOGRAPHY

The author Ansha Ali was born in Degega town found at 32 km from Dessie, south Wollo Zone. she attended primary and junior education at Degega primary and junior school. Then, joined WoizeroSiheen secondary school 1983 and completed her high school in 1986.in 1987she got a nine month training certificate from Agarefa Agrictural training center. and also joined Bekoji agricultural college in 1994 and acquired her Diploma in animal science in 1996 E.C. she also acquired her BSC degree in Animal Science in2004 from BahirDar University. Before she came to BahirDar University for Masters, she was worked at KalluWoreda with different responsibilities. First, she worked as a development agent for seven years and as animal production and forage expert for five years from June 2002 up to now she has in the position of animal production and health controlling process owner .

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LISTS OF ABBREVATIONS

ADF……...Acid Detergent Fiber.

ADL……..Acid detergent lignin

ADWG……..Average daily weight gain

ANOVA……Analysis of variance

BW…… Body weight

CP……..Crude Protein

CSA……...Central Statistics Agency

CT……..Condensed tennis

DMI……...Dry Matter Intake

FAO……Food and Agriculture Organization

GDP…….. Gross Domestic Product

ILR……...International Livestock Research Institute

kg/ha……..Kilo Gram per Hectare

masl……Meter Above sea level

ME……..Metabolizable energy

Mg……..Mili gram

Mm…….Mili Meter

N…….Nitrogen

NDF……..Neutral Detergent Fiber

OM…….Organic Matter

PA…….....Peasant Association

Qt……Quintal

SAS……Statistical Analysis System

TDMI …… Total dray Matter intake

TDN……Total digestible nutrient

ZcL_____Ziziphuscrisit leaves

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ABSTRACT

A study was conducted to evaluate the effect of feeding different levels of dried Ziziphus-spinachristi leaf on feed intake and live weight gain of local male goats at Kallu District, South Wollo zone, north east Ethiopia from November 2015 to February 2016. Twenty-five yearling growing intact local goats, with average body weight of 20.68± 0.72 kg were arranged in randomized complete block design (RCBD) with five treatments and five replications. Different levels Ziziphus-spinachristi leaf were supplemented in various treatment groups i.e. T1 (grass hay only) being control group, T2 (75% pasture grass hay, 25% Ziziphus), T3 (50% grass hay, 50% Ziziphus), T4 (25% grass hay, 75% Ziziphus) and T5 (100% Ziziphus-spina-christi).The experiment was conducted for 90 day of feeding trial during those days feed intake was measured daily and BW change was measured at 7 days (every week)interval throughout the experiment. There was significant (P< 0.05) increase in total dry matter intake of goats fed on supplemented diet than the control group fed on grass hay only. Mixing of the pasture grass hay diet significantly (P<0.05) improved animals feed in take from 440 to 592g/head/day at the minimum proportion of, 25% Ziziphus *mixture. However, there was no significant difference (P>0.05)in feed intake among the supplemented groups (T2-T5) as the proportion of Ziziphus-spinachristi increased. Goats in the control group and in 25% Ziziphus treatment diet gained31.4 and 46.7 g , which was not significantly different. The highest (P< 0.05) average daily body weight was gained in goats supplemented with highest level (100 %) of Ziziphus group. There was significantly (P<0.05) increasing trend of body weight gain was observed at increasing level of different proportion of leaves were given as at 50% (90g/day), 75 %(110g/day) and 100 % (190g/day). Feed conversion ratio significantly (P<0.05) increased with increased inclusion level ofZiziphus- spinachristi leaf. Goats under supplemented treatment diets had significantly higher (P < 0.05) feed conversion ratio than the control groups. Generally, the results of the current study showed that supplementation of goats with above 50% level of dried Ziziphus-spinachristi leaf in their diet significantly increased feed intake and body weight gain by improving feed conversion efficiency of goats.Ziziphus-spinachristi can be used as a potential feed to goats feed which is usually available in arid and semi-arid rangeland of the study area.*

Key words: *Feed intake, Goats,Grasshay,Weight gain, Ziziphus-spinachristi*

CHAPTER 1: INTRODUCTION

Ethiopia has diverse agro-ecological zones suitable for livestock production. Agricultural scenario in Ethiopia is characterized by the pastoralism in low land area, and mixed farming systems in mid and highland areas. Livestock have traditionally been an important component of the agricultural industry in country (Alemayehu Mangestu,2002). Ethiopia has one of the largest livestock population in Africa with the estimated domestic animal number of 57.83 million cattle, 28 million sheep, 28.6 million goat, 1.23 million camels, 60.5million poultry, 2.1 million horses, 0.4 million mules and 7.88 million donkeys. (CSA, 2016). Ethiopian possesses one of the largest goat populations in the continent that serves multiple functions to communities that herd them. The recent data from CSA (2016) indicated that the growth rate of goat population is 1.1% with off-take rate of 35%. In Ethiopia, goat production accounts for 16.8% of total meat supply (AmhaSebsibe, 2008) and 16.7% of milk consumed in the country (TsedekeKocho, 2007).

In Ethiopia, almost all goats are produced in mixed crop-livestock and pastoral and agro-pastoral systems. They are managed under extensive traditional systems and produced the lowest compared to other sub-Saharan African countries. Though the purpose of keeping goats vary from area to area due to economic, cultural and ecological factors (GetahunLema, 2008), they are mainly maintained for fulfilling multiple roles, ranging from socio-cultural purposes to providing meat, milk and manure (WorknehAyalew*et al*., 2003) .

In Ethiopia, goats are preferably reared by rural low income farmers, attributed to their low cost of production, adaptability to hot environment through their dynamic feeding behavior, high fertility and growth rates and fast reproduction cycle (TesfayeTsegaye, 2009). The goats play an important role by improving the livelihood of resource challenged farmers by creating alternative employment opportunities, enhancing family income by sale of live animals, skin, manure, etc. Therefore, demand for goat's meat is on the rise throughout the world especially in Ethiopia (Tesfaye Tsegaye, 2009). This is mainly due to increased human population coupled with income growth. Despite the large size of the country's goat population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors such as poor

nutrition, prevalence of diseases, lack of appropriate breed and breeding strategies and poor understanding of the production system as a whole. However, the indigenous goat breeds have relative advantage in their natural habitat. According to Kiwuwa G(1992), the broad genetic variability of African small ruminant breeds enables them to survive under stressful environmental conditions, including high disease incidence, poor nutrition and high temperature.

Poor nutrition is one of the major impediments which limit the performance of goats (Felekech Lemecha *et al*., 2013). The major animal feed resources include communal grazing land, crop stubble, road and riverside pasture and crop residues which are very low in quality and quantity (YeshitlaAdmassu , 2008). In lowland areas, goats rely on browsing and grazing whereas in the highlands they depend on communal grazing, fallow lands and crop residues (Aschalew Tsegahune*et al*., 2000). The available feeds from such sources are insufficient to provide nutrients beyond maintenance requirements, as a result poor grazing and low quality feeds especially in terms of energy or protein leads to undernourishment and low productivity. The situation is aggravated during the dry season where natural pastures became over-matured being critically deficient in protein and energy contents (AdugnaTolera*et al*., 2000 ;Tsige yohannes, 2000). According to Ayele Solomon *et al*.,(2003) lack of information on goat feeding systems and feed supplement utilization are also main constraints to goat's production performance.

It is thus imperative to supplement the available poor quality feed resources with some amount of concentrates for enhanced productivity of farm animals. However, the use of conventional feeds as a supplement is usually limited under smallholder livestock production systems due to inaccessibility and high cost of such feed ingredients (Tessema Zewdu *et al*., 2003). In order to mitigate the problems associated with the lack of protein supplement, there is a need to look for alternative cheap protein sources from unconventional feed resources that are easily accessible by the smallholder farmers (Tibebu Manaye*et al*., 2009).

Browse plants play a significant role in nutrition of ruminant livestock in tropical regions. Browse species, because of their resistance to heat, drought, salinity, alkalinity, drifting

sand, grazing and repeated cutting, are the major feed resources during the dry season (Fagg and stewar*t*, 1994). Some parts of browse species can be found during the dry season including pods, fruits and leaves. Most trees/shrubs produce their leaves during wet season, thus browse is more available during the spring (August to May) (Palgrave, 1983).

The nutritional importance of browse is especially significant for free ranging goats in extensive communal system of production. There are two indigenous Ziziphus species (*Ziziphus-spinacristi*and *Ziziphus-abyssinica*) growing in many parts of dry land Ethiopia. Out of the two *Ziziphus t*ree species, *Z.- spinacristi*is more dominant in Southern Ethiopia including the study area and it is also drought tolerant and is possible to get good leaf biomass even at times of poor rainfall and dry season; this plant is evergreen, found everywhere, there by contributing to solving the feed scarcity of small ruminant partially. The nutritional and supplemental values of air dried *Ziziphus* leaf for small ruminant indicated promising results and has crude protein (CP) content of 14.5% (BruhWeldemariam*et al*., 2014). However, limited work has been done for maximizing and efficient use of this locally available feed resource.

Traditionally farmers of the study area are observed lop the branches of these trees for the purpose of fence, fire wood and the leaf part is feed to their animals right at the field and the left over will be decompose or feed by other animals. Collecting the leaf and storing for the dry season supplementation is not practiced in the area due to lack of awareness on browse leaf supplementation for their animals. Therefore the Objectives of this study were mentioned below…

1.2. OBJECTIVES

1.2.1. General objective

To evaluate the feeding value of *Ziziphus-spinachristi* for goats under on farm condition.

1.2.2. Specific objectives

1**.** To evaluate the chemical composition of dried *Ziziphus-spinachristi* leaves.

2. To evaluate the effect of *Ziziphus-spinachristi leaf* supplementation on feed intake and bodyweight change on local goat feed a basal diet of grass hay.

CHAPTER 2: LITERATURE REVIEW

2.1. Goat production systems in Ethiopia

Sheep and goat in Ethiopia and most developing regions are kept under traditional extensive systems, largely produced in mixed crop–livestock; specialized pastoral and agro-pastoral systems. Goat production in Ethiopia is described under low input production system and is operated by smallholder farmers. Smallholder production predominates in the highland mixed crop–livestock systems because of land and capital limitations. Large flocks are maintained in the extensive lowland (agro) pastoral systems, while small flocks and tethering is practiced in densely populated areas (Solomon Gizaw*et al*., 2010). The main features of the low input goat production system are its full dependence on natural resources and the limited demand for inputs. This system is characterized by land scarcity, severe resources degradation and recurrent drought (IBC, 2004). According to EARO (2000), in Ethiopia, goats are maintained under two broad production systems.

2.1.1. Mixed crop-livestock farming system

In a mixed crop–livestock production system, which is prevalent in humid, sub-humid and highland agro–ecological zones, goats are kept by smallholders and graze together with sheep and/or other livestock such as cattle. In these mixed-species grazing systems, goats complement cattle and sheep rather than compete with them for feed, because of their inherent ability to eat a wider variety of plant species (Lebbie, 2004) cited by Yoseph Mekasha, 2007). These mixed herds usually freely graze on communal pastures and seasonally on fallow cropland with no extra-supplement and receive minimum health care. However, due to the increasing population pressure in areas with this production system, free grazing is becoming limited and goats are now tethered, reflecting the challenge of procuring sufficient feed in this system (FARM-AFRICA, 1996).

2.1.2. Agro pastoral and pastoral system

In pastoral and agro–pastoral production systems, which are found in arid and semi-arid agro–ecological zones, goats are kept by nearly all pastoralists, often in mixed flocks with sheep, freely grazing or browsing in the rangelands (Matawork Kilkias, 2016). This production system is associated with the purely livestock based nomadic and transhumance pastoral production systems based largely on range, primarily using natural vegetation. In the lowlands of Ethiopia, livestock is comprised of large flocks and herds of sheep and goats, cattle and camels mainly transhumant, where only surplus are sold at local markets or trekked to major consumption centers. Extensive livestock keeping is the backbone of the economies of the lowlands (EARO, 2000).

2.2. Feeding behavior, feed intake and requirement of goat

Goats are essentially browsers that feed mostly leaf, fruits and twigs of shrubs and other ligneous plants. They will, however, eat grass and herbs when there is no other alternative (Matiwos Solomon, 2007). Knowledge of feeding habits has nutritional implication and it is important in improving the nutrition of animals (ESGPIP, 2008). The main reason for the wide distribution of goats in tropical climates is their ability to survive in harsh environments, with low rainfall levels (below 70 mm/year). Under these conditions, goats can utilize a wide variety of grasses, leaves and twigs (not normally eaten by sheep and cattle) owing to their browsing habit. This allows them to meet their nutrient requirements during adverse conditions (MulukenZerihun, 2006). They are highly active feeders and will travel greater distances than other domestic ruminants in search of food.

Several anatomical and physiological adaptations have been suggested for the feeding habits of goats. These include high tolerance for bitter, salty and sour substances (Goacher and Church, 1970) preference for a wide variety of chemical substances (Devendra, 1978). Goats have preference to eat at a height of 20-120cm above the ground due to their ability to stand with their hind legs for long periods. They have mobile upper lip and tongue that enable them to consume leaves between thorns (ESGPIP, 2008). Dry-matter intake is an important factor in the utilization of roughage by ruminant livestock and is a critical determinant of energy intake and performance in small ruminants. Quality of the

feed determines the voluntary intake of the animals. The higher the quality of the feed offered to the animal, the higher will be the intake and performance with goats on the diet (Cheeke, 1999). Animals eat to supply the tissue with nutrients required and stop eating to limit metabolic or physical discomfort, intake is restricted (controlled) by gut fill up to a breakpoint in digestibility, beyond which the relationship between intake and digestibility became negative, and controlled by the animal's requirements (Mohammed Ismail, 2005).

According to Romney and Gill, (2000) plant physical factors also affect intake and hence animal's performance, these factors can directly influence the gut volume occupied by ingestion of a feed and the rate at which that volume is decreased by digestion and on ward passage. The content of fibrous cell walls is a major factor in this respect, since these structures are less soluble and take up more space than the cell contents (Mohammed Ismail, 2005).

Goats require nutrients for body maintenance, growth, reproduction, pregnancy, and production of products such as meat, milk and hair (Pinkerton and Pinkerton, 1999). In a grazing situation, animals having the highest nutritional requirements should have access to lush, leafy forage or high quality browse. In a barn feeding situation such as during some cold months, these same animals should be offered the highest quality hay available. Whether grazed or barn fed, goats should be supplemented when either the forage that they are grazing or the hay that they are fed do not contain the necessary nutrients to cover their nutritional requirements.

Dry-matter intake is an important factor in the utilization of roughage by ruminant livestock and is a critical determinant of energy intake and performance in small ruminants. Quality of the feed determines the voluntary intake of the animals. The higher the quality of the feed offered to the animal, the higher will be the intake and performance with goats on the diet (Cheeke, 1999). The quantity of protein together with the energy utilization determine growth rate (Vanes, 1979). Growth rate of kids increased with increasing protein content of concentrate feeds offered *ad libitum* to Damascus kids weaned at 76 days of age (Louca and Hancock, 1977). Similarly, Mavrogenis*et al.* (1979) reported that both the growth rate and feed utilization of kids fed on concentrate *ad libitum* (10.9, 14.7 and 16.2% CP) were higher with high protein diets up to seven months of age. In the same study, male

kids responded positively to increased protein level in the diet, whereas female response was only marginal.

Indigenous goats in the tropics fed to appetite have a daily dry matter intake in the range of 1.8-4.7% of body weight, equivalent to 40.5- 131.1g/kg body weight$^{0.75}$daily. Of these, meat breeds had a daily dry matter intake of 1.8- 3.8% of body weight, and 40.5-127.3g/kg body weight$^{0.75}$ (Devendra and Burns, 1983 2.2 g DCP were required per g live weight gain.

Various studies conducted on dry matter and nutrient intake of local breed sheep and goats in different parts of Ethiopia indict438.48, 421.07, 859.55, 107.28, 684.36, 85.93,469.8, 282.76 and 50.8g/day intake of hay DM, concentrate DM, total DM, CP, OM, ASH, NDF, ADF and ADL intake per day, respectively (Seid Mohammed, 2010).

2.3. Major feed resources for goats

2.3.1. Natural pastures and grass hay

Reports on the major livestock feed resource base in Ethiopia indicated that grazing natural grasslands contributes 61.92%, crop residues 27.01%, hay 6.55%, improved forage 0.52%, agro-industrial by-products 0 78%, and other type of feeds 3.6% of the total supply (CSA, 2010). Natural pastures are naturally occurring grasses, legumes, herbs, shrubs and tree foliage that are used as animal feed. The availability and quality of natural pastures vary with their species variety (Table 1), altitude, rainfall, soil type and cropping intensity. The level and distribution of available soil nutrients and water are the main limiting factors. The quantity and quality of feed obtainable from natural pastures declines as the dry season progresses. The protein content and digestibility of most grass species decline rapidly with advancing physiological maturity of the plants and reaches very low levels during the dry season. Most tropical forages do not supply energy beyond maintenance requirement of animals (Simret Betsha, 2005).

At advanced maturity, forages are characterized by high levels of cell wall fiber and low nitrogen (N). The fiber (NDF) value greater than threshold level of 60% resulted in decreased voluntary feed intake, increased rumination time and decreased conversion efficiency of ME. Conserving of natural pasture into hay for dry season use is very important. However, traditionally harvesting of native grass hay is usually delayed into the

dry season, and thus leads to lose of nutritive value. Hay harvested after maturation had CP contents less than 5%, which is below the level (7.5%) required for maintenance by ruminants (HabtomNegussie, 2012).

The chemical composition of grass hay reported from different experiments indicate that hay contain 90.4%DM,12.3%ASH,87.7%OM, 6.7%CP, 71.9%NDF, 44.4%ADF, and 4.7%ADL (Seid Mohammed (2010); Habtom Negussie, 2011) after reviewing the chemical compositions of hay collected from various sites in Ethiopia by different outers reported a chemical composition of 87-94% DM, 3.75-8.7% CP, 64.2-77% NDF, 37.9-43.7% ADF, 4-7% lignin and 7.5-13.7% ash and energy value ranges 6.5-8.2 MJ ME/kg DM). In his own experiment, Habtom Negussie (2011) noted hay to contain 89.6%DM, 12.65%ASH, 87.35%OM, 7.79%CP, 65.2%NDF, 34.55%ADF, 5.85%ADL, 30.65 Hemicelluloses and 28.7% Cellulose. Based on this assessment, Habtom Negussie, (2011) conclude that due to the low CP and high NDF concentration of hay, maximal livestock production cannot be achieved on hay alone. Therefore, for reasonable level of production, animals subsisting on hay require supplementary protein, which could be from oil seed cakes or non-protein nitrogenous (NPN) sources.

Table 1. Nutritive value of some natural pasture grass and hays

Feed quality parameter	Mixed natural pasture	Buffel grass	Bermuda grass
Dry matter (%)	-	33.7	20.9
Organic matter (%DM)	91.0	85.9	90.2
Neutral detergent fiber(%DM)	66.3	66.9	78.8
Acid detergent fiber(%DM)	38.8	38	36.3
Acid detergent lignin(%DM)	4.7	5.2	4.5
Crude protein(%DM)	6.6	11.1	12.7
In vitro DM digestibility (%)	62	59.2	55.0
Net energy for maintenance (Mcal/kgDM)	1.34	1.21	1.14
Net energy for gain (Mcal/kg DM)	0.77	0.65	0.58
Phosphorus (%DM)	0.21	0.27	-
Calcium (%DM)	0.55	0.26	-

Source: AdugnaTolera, (2007)

2.3.2. Crop residues

Crop residues are becoming increasingly important as sources of roughage in feedlots. Major Field crops produce large quantities of crop residues (straws, stovers and haulms) in addition to grain. These include cereal straws (e.g. tef, wheat, barley, maize, sorghum etc.), grain legume haulms (e.g. haricot beans, field peas, chickpeas, lentils, groundnut etc.). Sweet potato and cassava tops and vines, sugarcane tops and enset by-products are also becoming very important in small scale fattening. However, the principal crop residues used for animal feeding are the straws of cereals and pulses. The most important components of the crop residues are the leaves and stems that remain after the grain is harvested. Crop residues are fibrous materials that are by-products of crop cultivation. Crop residues have low crude protein content in the range of 3–13% of the dry matter. This is a basic limitation in residues such as straw and bagasse with crude protein contents around the border-line level of 6–7% required to create an appropriate rumen

environment to promote dry matter digestibility and intake (AlemuYami and R.C. Makel, 2008).

The nutritive value of crop residues is variable depending upon the species and variety of the crops, time of harvest, handling and storage conditions and other factors. Cereal straws and stovers are generally characterized by relatively low nutrient content, high fiber content, low digestibility and low voluntary intake (limited consumption) by animals. The nutrient supply of many cereal straws such as teff, barley and oat straws is closer to the nutrient supply of medium quality native grass hay. Thus, good quality straw can be regarded as a good roughage source for feedlots next to native grass hay (Yeshitila Admassu, 2008).

The haulms of pulse crops (grain legumes) represent good quality roughage with a CP content of 5-12%. Most roughage feeds (hays and straws) are bulky and of low nutrient density, which makes the transportation cost very expensive relative to the nutritive value of the feeds especially when they are transported over a long distance. Thus, provision of such feeds should be planned based on easy accessibility of source of supply. In general, as much as possible, all roughage feeds should be locally available and relatively inexpensive. If they have to be transported long distances they have to be dense and highly digestible to keep the price of the feed to a minimum Tessema Zewduetal,.(2003).

The crop residues are bulky and of low nutrient density. Most residues are deficient in fermentable energy and minerals. Crop residues have low palatability and digestibility that leads to poor intake, particularly when fed as the sole roughage. The availability of crop residues is closely related to the farming system, the type of crop produced and the intensity of cultivation. Teff, wheat and barley straws are the major residues available in the highlands. A drought period was observed in the study area .Seyoum Bdeiye and Zenash Sileshi,(1989).

2.3.3. Agro industrial byproducts

Agro-industrial by-products are the by-products of the primary processing of crops, including bran and related by-products of flour mills, oilseed cakes from small and large-scale oil processing plants, brewery by-products and by-products of the sugar factory such as molasses. Agro-industrial by-products such as oilseed cakes and meals, wheat bran and molasses are important sources of relatively high quality feeds mostly used in urban and peri urban livestock production. They make up part of concentrate rations. Oilseed cakes serve as protein supplements in concentrate mixtures. (Adugna Tolera, 2007).

The major agro-industrial by-products can be classified as oilseed and grain by-products obtained from the processing of oilseeds and grains. Such by-products are becoming increasingly important in feeding system (Girma Hailu, 2013). Wheat bran is most commonly used ingredient than other industrial byproducts and relatively available in Ethiopia. It is the coarse outer covering of the wheat kernel separated in the process of commercial milling. Wheat bran is quite palatable, and is well known for its laxative characteristics because of its swelling and water holding capacity (Simret Betsh, 2005). It is a good source of phosphorus, energy, protein and most of the water-soluble vitamins (McDonald *et al*.,2002).

Wheat bran is the major milling by-product used as livestock feed in Ethiopia. Wheat bran is one of the energy source concentrates containing easily digestible carbohydrates (α-linked polysaccharides). Such feeds are readily digested in the rumen with high energy yielding potential. Wheat bran is a relatively good source of most of the water soluble vitamins except niacin. The CP in wheat bran has a relatively high digestibility of about 75%. The fiber and energy content of wheat bran may vary depending upon the quality of wheat being milled and the exact processing method used as these factors affect the overall blend of the bran components.

Alem Dida, (2014) reported chemical composition of wheat bran to be 89.5%DM, 4.65%ASH, 95.4%OM, 16.96%CP, 38.6%NDF, 12.2%ADF and 2.9%ADL. Simiret Betsha, (2005), reported that 90.56%DM, 85.15%OM, 20.1%CP, 44.13%NDF, 12.74%ADF, 3.52%ADL and 5.41%ASH. Tesfaye Tsegaye, (2009) reported 89.28%DM,

4.4%ASH, 95.6%OM, 13.8%CP, 32.72%NDF, 9.46%ADF and 2.35%ADL. Wheat bran is not considered to be a suitable feed for pigs and poultry because of its high fiber content (McDonald *et al*., 2002; Pond *et al*., 1995).

Among the feed resources derived from oil processing industry, noug seed cake is available in several areas of Ethiopia (Girma Hailu, 2013). The cakes after food oil extraction are widely used as protein supplement to low quality hay and crop residues In Ethiopia, oil extraction is done almost entirely by mechanical press, where old machines are predominant in the oil milling industry, and these extraction processes affect the efficiency of edible oil production and equally affect the meal quality (Abebaw Nega, 2007). The cakes are rich in crude protein; about 95% of the nitrogen in oil seed meal is present as true protein, with apparent digestibility coefficient of 0.75 to 0.9 and is of good quality when biological value is used.

Oilseed cakes produced by mechanical extraction of the oil from the seeds contain more fat and fiber and less protein than those produced by solvent (chemical) extraction. The energy content varies from 2.03 to 3.7 Mcal of metabolizable energy (ME) per kg DM depending on the processing method. Its content of net energy of maintenance (NEm) varies from 2.02 to 1.28 Mcal per kg DM and the net energy of gain (NEg) varies from 1.36 to 0.71 Mcal per kg DM (Solomon Mogus, 1992).The calcium content is usually low which varies from 0.17 to 0.72% of DM, whereas most oilseed cakes are high in phosphorus content (0.75-1.31%). In general, oilseed cakes have high phosphorus, potassium and magnesium contents and low content of calcium and sodium (Solomon Mogus, 1992).

According to Seyoum Bediye and ZinashSileshi (1989) the chemical composition of noug cake are 32.7% CP, 62.1% IVOMD and 9.3 MJ ME/kg DM. GirmaHailu ,(2013) reported 93.2%DM, 90.2%OM, 29.8%CP, 36.3%NDF, 30%ADF and 11.88%ADL. AlemDida, (2014) reported, 91.69% DM, 10.95%ASH, 89.05%OM, 33.1%CP, 38.2%NDF, 30.45%ADF and 13.9%ADL. Tesfaye Tsegaye, (2009) reported 92.25%DM, 11.88%ASH, 88.12%OM, 33.6%CP, 27.53%NDF, 25.27%ADF and 10.45%ADL in noug cake.

2.3.5. Foliage and pods from naturally growing trees and shrubs

Use of herbaceous or tree legumes as supplements during prolonged dry seasons or drought is also possible, but wider use is constrained by limited availability when and where it is needed most. Foliage of trees such as different Acacia species and Balanitesaegyptiaca as well as the pods and fruits of Prosopis and different Acacia species can be used as a substitute for concentrate supplement. Foliages from trees and shrubs contribute a significant proportion of feed to ruminants in traditional livestock production systems .Farmers and pastoralists traditionally lop branches of trees and use them as supplementary feed for their animals during the dry season.

According to Teferi Aregawi (2008), nearly all the domesticated ruminants consume browse species at one time or another during the year, depending upon availability of alternative feed resources and the preference by the animal species. The browse species are used as livestock feed both in the wet and dry season. In the wet season, most of the foliages are consumed directly from the live plant and some of them are lopped and sometimes offered as cut and carry feed. The leaves and pods of trees and shrubs are sources of good quality feed during the dry season when herbaceous forages are in short supply (Table 2). Foliages from trees and shrubs are the preferred forage particularly for goats. In harsh and arid conditions, trees provide more edible biomass than pasture and the biomass remains green and high in protein.

Trees can tap water and nutrients deep in the soil profile because of their deep rooted nature. The leaves and pods from fodder trees and shrubs usually have higher CP and lower fiber content than dry grass forages and cereal crop residues. Grazing and browsing comprise the feed supply in pastoral areas. The higher rainfall areas of the pastoral zone are characterized by dense thorn bush of low carrying capacity when compared with tropical grasses; browse is richer in protein and minerals in the dry season (AlemuYami,RC.Merkel, 2008).

The crude fiber content of browse also tends to be lower than that of grasses and usually ranges between 20 and 40% and is even lower in shoots and leaves. Content of crude fiber suggests that the energy content of browse is higher than that of dry grass. Browse could, therefore, supplement the low protein content of grass forage during dry periods. Thus,

proper and strategic use of these feed resources as supplementary feed during the dry season can help to minimize seasonal fluctuation in animal productivity. However, the gradual decrease in the number of browse trees and shrubs and inadequate management systems to optimize utilization of the existing trees and shrubs appears to be a problem in this regard. In low the lands, live stock production is all most totally dependent on it. However grazing lands do not full fill the nutrient requirement of animals particularly in sub tropics as recommended by Devendra and Burns, (1983).

2.4. Effects of supplementation on performance of goats

Dry matter intake is dependent on whether the forage is fed alone or with concentrate, the latter generally increases overall DMI (Payne and Wilson, 1999). However, in goats given forage *adlibitum*the main factor influencing performance is the level of DMI (Morand-Fehr *et al*., 1987). Concentrates may improve the level of forage intake by supplying fermentable carbohydrates or proteins. Moreover, goats ingest large quantities of concentrates to achieve high performance (Morand-Fehr and Sauvant, 1987). With concentrate feeds offered *adlibitum*, their level of intake depends on different factors: their physical form, their palatability, the type of forages and the fact that concentrates are in mixture or not (Giger and Sauvant, 1991).

Mowlem (1985), showed that high rates of concentrate allowance reduced forage intake by goats. Voluntary feed intake of concentrate before kidding is influenced by level of energy and protein in the diet. Data on doe performance after kidding indicated that the voluntary intake of concentrate was slightly above feed intake before kidding (Aregheore*et al*., 1992). Furthermore, Silianikove et al., (1993) demonstrated breed variation in utilization of poor quality diet, even within tropical breeds. In the study of Silianikove et al., (1993) goats living in desert ecology maintained higher feed intake without consequent decline in DM digestibility because of higher fermentation, than goats living beyond the desert which exhibited relatively lower DM digestibility because of increased feed intake. The desert goats reportedly combined higher fermentation rate and longer retention time, which allowed maximum intake and digestibility. The quantity of protein together with the energy utilization determine growth rate (Vanes, 1979). Growth rate of kids increased with increasing protein content of concentrate feeds offered *adlibitum to* Damascus kids weaned at 76 days of age (Louca and Hancock, 1977).

Similarly, Mavorgenis et al., (1979) reported that both the growth rate and feed utilization of kids fed on concentrate *adlibitum*(10.9, 14.7 and 16.2% CP) were higher with high protein diets up to seven months of age. In the same study, male kids responded positively to increased protein level in the diet, whereas female response was only marginal. Contrary to this, Shahjalal et al,. (2000) reported that the higher CP intake from high protein diet in goats supplemented with high and low protein did neither improved growth rate nor feed conversion efficiency. However, there is evidence that DM intake and growth rate in Alpine and Nubian goats increased linearly as the level of protein concentration in the diet increased (Lu and Potchobia, 1990).

2.5. Description of *Ziziphus-spinachresti*and its use as animal feed

Ziziphus-spinachristi is a shrub, sometimes a tall tree, reaching a height of 20 m and a diameter of 60 cm; bark light-grey, very cracked, scaly; trunk twisted; very branched, crown thick; shoots whitish, flexible, drooping; thorns in pairs, one straight, the other curved *Z.-. spinachristi* is native to a vast area of Africa stretching from Mauritania through the Sahara and Sahelian zones of west Africa to the Red Sea. It is drought hardy, very resistant to heat and can be found in desert areas with even 100 mm rainfall annually. It prefers edges of ponds, river and wadi banks where groundwater is available. The tree is frost tender, can withstand water logging for up to 2 months and 8-10 months of dry season. It is an aggressive colonizer, forming spiny, impenetrable thickets. *Z.- spinachristi* prefers alluvial plains with deep soils but it can also grow on clay where water is available and saline soils. It is well distributed in Chad, Djibouti, Eritrea, Ethiopia, Kenya, Libyan Arab Jamahiriya, Mali, Mauritania, Nigeria, Pakistan, Senegal, Somalia, Tunisia, Turkey, Zimbabwe. (Orwaet al.2009).

The high CP content of browse species is well documented and is one of the main distinctive characteristic of browse compared to most grasses. Norton (1998) reported a range of CP contents from 12 to 30% for tropical tree legumes, and Le Houerou (1980) gave a mean of12.5% in West African browse species with about 17% for leguminous species. Generally, the CP content in browse has been required (7%) for microbial activities in the rumen (Norton, 1998). Important factors causing variation in the

chemical composition of browse forages include soil type (location), the plant part (leaf, stem location, some authors have reported that browse plants Younger leaves are richer in N than mature leaves contain more N than the latter (Table 3) (Rittner and Reed, 1992).

With regard to the fiber content, Rittner and Reed (1992) reported similar mean for NDF and lignin contents across different ecological zones of Africa 40.1% and 11.7% in DM of *Ziziphusspina-christi*Njidda and Olatunji(2012). According to Njiddaand Olatunji (2012), chemical analysis result the lowest mean DM content of *Ziziphus-spinachristi* was 153.65-140.80 g/ kg DM and*Ziziphus-spinachristi*-had the highest value of 785.30 g kg/ DM. The highest neutral detergent fiber content(NDF) of 575.40 g/kg was found in *Ziziphus* leaves, while the acid detergent fiber (ADF) levels in the experimental leaves of *Ziziphus* ranged from 205.90- 228.30 g /kg DM (Njidda and Olatunji, 2012).

Table 3 Nutritional contents of different parts of *Ziziphus-spinchristi*

Ziziphus-spina-christi	Fruit	Seed	Leaf
Carbohydrates %	63.8	21.8	25.8
Protein %	3.1	29.6	6.8
Fat %	2.2	3.9	3.3
Calcium mg/100g	177	154	1270
Iron mg/100g	0.6	4.4	7.2
Phosphorus mg/100g	135	1090	85.4
Sulphur mg/100g	94.5	1180	195
Potassium mg/100g	1910	1130	673
Magnesium mg/100g	56.3	301	169
Zinc mg/100g	0.8	9.2	1.5
Copper mg/100g	0.6	1.6	0.3
Manganese mg/100g	0.4	3.5	3.5
Sodium mg/100g	9	14.1	22

Source**:** Aden Faundation, 1992

2.5.1. The chemical composition of the different parts of *Ziziphus-spinachristi*

The dry matter (DM) varied significantly among the different parts. The highest DM content was observed in the green shoots while the flesh showed the lowest DM content (Table 4). The DM content *Ziziphus-spinachristi* leaves is higher than that reported in the leaves of Acacia mellifera (285.7g/kg), and *Zizyphus-abyssinica* (753g/kg) (Ikhimioyal *et al*., 2005).According to Shamseldein et al.(2014), the crude protein (CP) content were variable significantly a high CP content (14.77%) was found in the leaves, followed by the flesh, and the lowest CP was observed in the green shoots which is far higher than the CP of *Ziziphus-spinachristi* (1.4 g/kg), reported by Guinand and Dechasalemessa(2002). The crude fiber (CF) content was highest in the seed cakes while the flesh showed the lowest value. According to Shamseldein et al.(2014) crude fat (EE) content varied significantly among the different parts and the highest content was observed in the leaves and the lowest content in the green shoots. The ash content was highest in the green shoots while the flesh showed the lowest value. *Ziziphus-spinachristi* leaves have a very low ash contents especially when compared with that of Ficussp (110g/kg), Acacia mellifera (50g/kg), *Ziziphus-abyssinica* (70g/kg) (Elamin and Babiker , 2000), and with the ash content in the leaves of Almond tree (8.8%), Cherry tree (9.3%) and Apricot tree (15%). The nitrogen free extract) NFE) content was highest in the flesh while the seed cakes showed the lowest value (Nahand et al. ,2012).

Table 4. Approximate analysis of the different parts of Ziziphus-spina Christi

Part	DM%	EE%	CP%	CF%	Ash%	NFE%
Green shoots	96.59	0.3	8.03	14.21	10.03	67.43
Leaves	96.15	1.12	14.77	12.72	8.47	62.92
Flesh	94.61	0.94	10.55	13.5	2.62	72.39
Seed cake	94.63	1.09	8.65	32.46	3.46	3.12

Source: Shamseldein et al. (2014)

2.5.2. Rumen dry matter degradation of different parts of *Ziziphus-sspina Christ*

Effective Degradability (ED) of DM was decreased with increase in outflow rates. Mupangwa (1997), observed that as general, effective degradability of DM to decrease as the outflow rate increase. The immediately soluble fraction ‘a’ ranged from 3.19% in flesh to 12.83% in leaves.The insoluble but rumen degradable fraction was least in green shoots (23.09%). This is a reflection of the fact that its DM component was most readily soluble. With a similar slowest rate of degradation per hour of the rumen degradable fraction in green shoots and leaves, these leaves appear to be potential sources of energy for use by microorganisms in the rumen. Green shoots and leaves had less than 50% DM loss during 24 hours as compared to the over 60% value obtained for flesh. However, beyond 72 hrs incubation, all the leaves, flesh and seed cake had DM disappearance values above 60%. The relatively high soluble DM values in these tree leaves reveals the potential of their being good sources of nutrients for microbial growth.

CHAPTER 3: MATERIALS AND METHODS

3.1. Description of the study area

The experiment was conducted in Kallu district, south Wollo zone in Amhara Natonal Regional State, south east Ethiopia. The district is located at a distance of 23 km South east of the zonal city Dessie and 375 km from Addis Ababa on the main road to Mekelle. It has an elevation of 1300 to 2870 m above sea level and lies between 39° 35' East longitude and 12° 15' North latitude. The area receives a bimodal rainfall distributed from March to May for the short rainy season, and June to September for the long rainy season with average annual rain fall of 800 to 1000 mm. The mean maximum and minimum temperature are 27 and 14.6°C, respectively (District OAD,2014).

The district has 30 rural and 4 urban kebeles. Crop livestock or mixed agriculture is the main for the economy of the district. However the production of agricultural out-put is constrained by several factors including traditional farming method, natural resource degradation, continuous drought, erratic rainfall distribution limited use of modern agricultural technologies and rapid growth of population has resulted in fragmentation and reduction of farm size contributed much on the production and productivity of food crops and forage production. Small ruminant production is the main livestock component of the study area followed by cattle production. About 46,270 goats and 21,625 heads of sheep were found in the district (District OAD,2014 unpublished document). The major feed source in the study area are natural pasture and crop residues, the feed source from the range, which includes different types of grasses, browsing trees and shrubs.

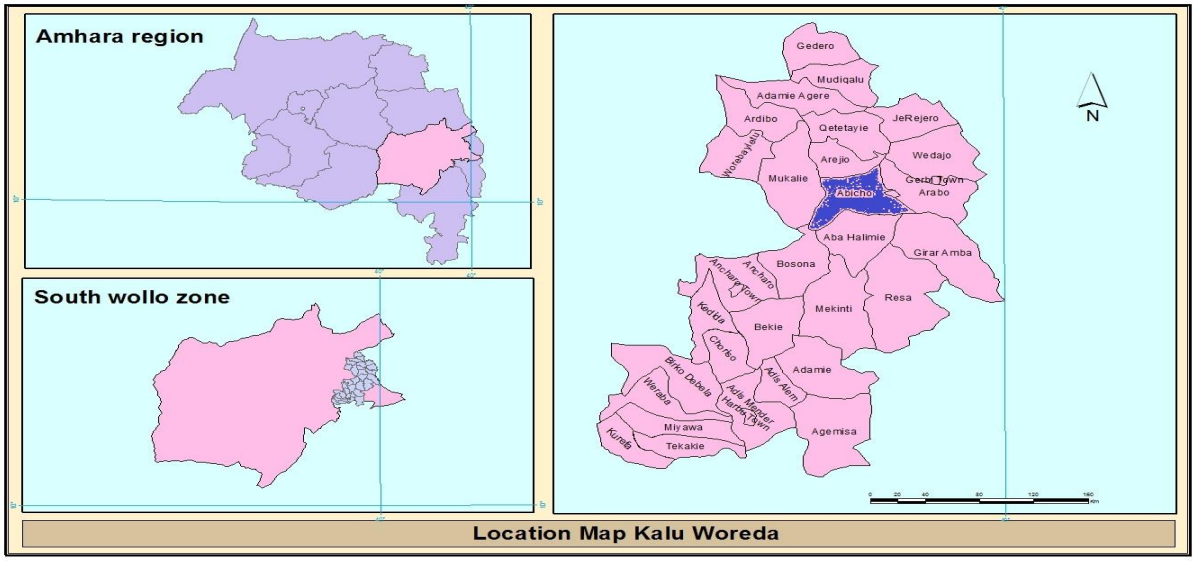


Figure 1 Map of study area

3.2. Peasant association and farmers selection

One Kebele (PA) from the low land PAs of the district was purposively selected based on the availability of *Ziziphus* tree and sufficient of goat population. Fifteen volunteer farmers who owned more than 10 goats were selected from the PA in cooperation with agricultural development workers of the area. The volunteer participant farmers (purposely selected goats owners) from selected peasant association (PA) were households of three villages in the PA. The growing male goats were selected from the flock based on their body weight and allocated to different blocks with an average of 3goats from individual farmers. Totally the study was conducted using participated 9 small scale farmers and 25 male goats. Farmers and development agents of the PA were given training before the commencement of the research on the purpose of the research, how to supplement their animal, housing and sanitation of their animals.

3.3. Experimental animals and their management

Twenty five male goats of local breed with initial body weight of 20.68± 0.72 kg and average age of 1 year at the start of experiment were used. The age of the experimental goats were estimated based on their dentitions and information obtained from the owners. The goats were drenched with anti-helminthes, sprayed against external parasites and were vaccinated against the common diseases of goats in the area before the beginning of the

experiment. The initial weight of animals were taken at the beginning of the experiment and was continued at weekly interval using spring balance.. Animals were weighed at morning following overnight fasting to avoid gut content variation. In addition, animals were adapted to consumption of the dietary treatments and new intensified management for 15 days prior to the actual trial. Experimental goats were separated from the other animals and kept in a fenced temporary house until the end of experiment under farmers' control. They have individual feeding and watering trough and follow up by the farmers with regular visits and monitoring by researchers on house cleaning, health and supplementing of the animals. Water and common salt were available free choice.

3.4. Experimental Feeds and Their management

Fresh *Ziziphu-sspinachristi* leaves were bought from farmers on contract bases from the selected PA(Abecho Kebla). Leaves were harvested regardless of tree age and trimmed from its twigs. The trimmed leaves were then spread thinly on plastic sheet and put under shade and turned regularly to ensure uniform drying for safe storage before the execution of the experiment. The air dried *Ziziphus*-spinachristi leaves were finally transported to the experimental site. Natural pasture hay was bought from a nearby farmers and hand chopped into the size of 3 to 5 cm for ease of consumption by the experimental goats.

3.5. Experimental Design and Treatments Diets

A randomized complete block design with five blocks based on the initial BW of the goats and five replications were used in the study. The experiment was conducted for 90 day of feeding trial and the five dietary treatments were randomly assigned to each animal in a block giving five animals per treatment. The supplements were offered according to their body weight (400 gm at the start of feeding trial on DM basis). The dietary treatments were formulated based on *Ziziphus-spinachresti* leaves to natural pasture hay ratio.

Treatment group-1 = Natural pasture hay only being control group

Treatment group-2 = 25% *Ziziphus-spinachresti* leaves + 75% natural pasture hay

Treatment group-3 = 50% *Ziziphusspina-chresti* leaves + 50% natural pasture hay

Treatment group-4 = 75% *Ziziphus-spinachresti* leaves + 25% natural pasture hay

Treatment group-5= 100% *Ziziphus-spinachresti* leaves

Daily feed offer and refusals were recorded for each goat to calculate daily feed intake. Samples of feed offer were collected per batch and that of refusals were collected over the experimental period for each animal and finally pooled for each treatment.

3.6. Chemical Analysis

Chemical composition of the treatment feed samples were analyzed at at Debre Berehan Agricultural Research Center Animal Nutrition analysis laboratory. Samples of dried offered feeds were dried overnight at 105 °C in a forced draft oven for determination of total DM content. Ash content was determined by combusting samples at 550 °C overnight and crude protein (CP) was calculated as N×6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed using the procedures of Van Soest and Robertson (1985)

3.7. Feed intake and growth performance

The treatment feeds were offered to individual animals two times a day at 7:00am and 1:30pm.Refusals were collected and weighed every morning to obtain an estimate of intake. Daily record of feed intake was maintained throughout the experiment. The goats were allowed 15 days of adaptation to experimental diets and the actual data collection continued for 90 days. Amount of *Ziziphus-spinachresti* leaves and natural pasture hay offered and refused was recorded daily to estimate intake. Daily record of feed intake was maintained throughout the experiment. Samples of refusal collected from individual animals every day were pooled over the entire experimental period and sub-sampled for analysis. Experimental animals were weighed on the first day of the feeding trial and subsequently at weekly intervals before offering the morning feed on the same day of the week after withholding feed and water overnight. The average daily gains of the animals were estimated in order to determine feed efficiency.

Feed intake was calculated by measuring daily offered and refusal of each treatment diet throughout the experiment. Daily feed intake was calculated as a difference of daily fed offers and refusals for each experimental goat, using the following formula.

- Feed intake = Feed offers- feed refused

The efficiency of feed utilization (feed conversion ratio) and live weight gains were monitored weekly days interval and calculated as follows.

- Feed conversion ratio = Feed intake/weight gain
- Feed conversion efficiency= Average daily weight gain /Total DM intake
- Live weight gain = Final live weight- initial live weight

Daily body weight gain was calculated as the difference between final live weight and initial live weight divided by the number of days.

- Daily weight gain = $\frac{\text{Final live weight- initial live weight}}{\text{Days on trial}}$

3.8. Statistical analysis

Data from the experiments on feed intake and live weight gain were subjected to the analysis of variance (ANOVA) in a randomized complete block design using the general linear model procedure of SAS (1998). Individual differences between means were tested using Tukey HSD test. The model used for the analysis of all parameters feed intake and weight gain parameters of the experiment was:

$Yij = \mu + \alpha i + \beta j + \varepsilon ij$

Where: Yij= response variable (feed intake and body weight gained) μ = overall mean; αi = ith treatment effect (feeds); βj= block effect (five-blocks); εij= ith random error (undefined factors).

CHAPTER 4: RESULTS ANDDISCUSSION

4.1. Chemical composition of feeds

The chemical composition of feeds used in this experiment is shown in Table5.The OM and CP contents were higher in *Ziziphus-spinachresti* leaf than in natural pasture hay. The DM content was similar between the experimental diets .The contents of ADL, NDF and ADF in *Ziziphus-spinachresti* leaf were found lower compared with that of natural pasture hay. The CP and OM contents of the experimental diets increased as the proportion (%) of *Ziziphus-spinahresti* increased.

Table 5. Chemical composition of experimental feeds

Experimental diets	Proximate analysis in % DM						
	DM %	OM	ASH	CP	NDF	ADF	ADL
T1-Natural pasture grass hay alone	89	8o.12	8.88	8	67.77	57.77	24.44
T2- grass hay + 25% *Z-. spinachristi*	89	79.55	9.45	9.7	56.3	45.8	18.88
T3- grass hay + 50% *Z-. spinachristi*	89	79	10	13.4	45.1	35.55	14.44
T4- grass hay + 75% *Z-. spinachristi*	89	78.45	10.55	17.1	33.33	24.44	9.55
T5- 100% *Ziziphus-spinachresti*	89	77.89	11.11	21	22.22	13.33	4.44

The CP content (8%DM) of the control groups fed on the pasture grass hay in this experiment was comparable to the result (7.49%)obtained by Belay Derebe et al,. (2014) around central Ethiopia and (5.15 % DM) obtained by (Nurfeta 2010). it had CP content above the minimum microbial requirement (7 % DM) in feeds to support acceptable ruminal microbial activity and the maintenance requirement of CP for the host ruminant (McDonald et al., 2010).

The CP content of the control treatment diet above maintenance requirement of CP for ruminant make goats fed the control diet to gain minimum body weight, but it was not significant ($p<0.05$), which necessitates supplementation. The DM content of Z- *spina-christi* leaves (89%DM) used in this study was comparable with the value (89.7% DM) reported by Solomon Melaku et al. (2010). But lower than the value (94.6% DM) obtained by Bruh Weldemariam et al., (2014). The CP content of Z-. *spinachristi*(21 % DM)obtained in this study is higher than the values 14.3 and14.5% DM reported by Solomon Melaku et al. (2010) and Bruh Weldemariam (2014) respectively. However, the NDF and ADF contents in the present study were much lower than the values (32.2% and 26.3% DM) reported by Bruh Weldemariam et al.,(2014) for *Z.- spinachristi* respectively. The CP content of all the experimental diets of the present study, ranging from 142.9-174.3 g/kg DM, was above the minimum level (75 g/ kgDM) required for optimum rumen function suggesting that all the diets can support maintenance requirement and certain level of production in ruminant animals (Whitman,1980).

4.2. Feed intake and growth performance

Results of mean daily DM intake of different grass *Ziziphus -spinchresti* mixtures fed to the experimental goats are given in Table 5. The sun-dried *Ziziphus-sspinachresti* leafs accounted for 0, 25, 50, 75 and 100% of the total dietary DM intake for treatments T1, T2, T3, T4 and T5 respectively (Table 2). The DM intake of all levels of grass hay and Ziziphus-*spinachresti* mixtures was significantly (P<0.05) higher than the control diet (natural pasture grass hay alone).

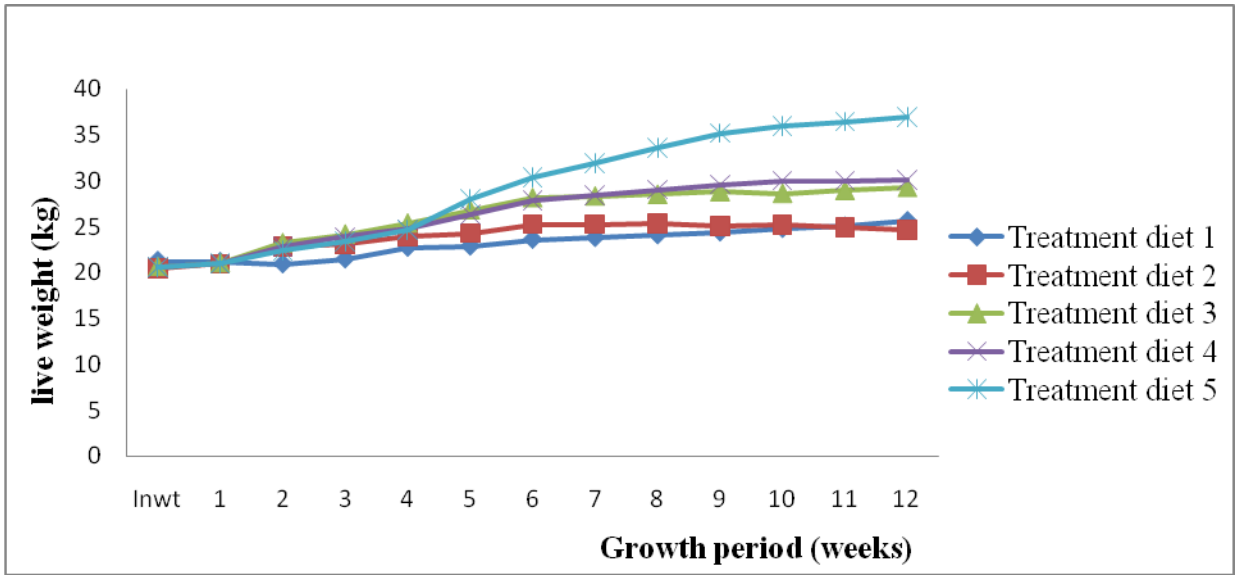
The DM intake increased with increasing level of *Ziziphus-spinachresti* leaves supplementation in the diet of goats. Total DM intake was higher in supplemented animals than in the control ones, consequently supplementation improved CP intake which was higher for supplemented goats than the control ones.

The DM intake of experimental goats significantly increased (P<0.05) with supplementation of *Z- spina-christi* leaf in the treatment diets which could be due to increased consumption of *Z- spina-christi* leaves as the leaves could be more palatable compared to the control diet. This is consistent with the report of BruhWeldemariam et al.,(2014), who observed increased intake in goats supplemented with *Z. spina-christi leaves* to a basal diet of grass hay. Similarly, Assefa, G et al., (2008) observed increased CP intake with increasing levels of tagasaste (Chamaecytisuspalmensis) supplementation in sheep fed a basal diet of grass hay. The increased DM intake with *Z- spinachristi* leaf supplementation may possibly be due to the very higher CP contents of *Z.- spinachristi* leaf.The low protein status of grass hay limits voluntary intake in ruminants, CP deficiencies that reduce the activities of rumen microorganisms are liable to reduce feed intake (McDonald et al., 2002).

The total DM intake in the result of this study was tended to be highest in the diet, 100% *Ziziphus-spinachresti* alone on which DM intake was 636g/ head/day. However, there was no significant difference (P>0.05) among different levels of grass hay-*Ziziphus-spinachresti* mixtures, these higher total DM intake is due to supplementation could be attributed to the supplying more nitrogen to the rumen microbes that in turn may have reduced the retention time by increasing the outflow rate and thus stimulating feed intake as suggested by **A**bdulrazak et al., (2005).Significantly lower intake result found in this

experiment in un supplemented goats might be due to the low level of CP in the grass hay which fed the control groups. In agreement with this result a study conducted by Foster et al., (2009), supplementation of sheep fed a basal diet of grass hay with legumes improved intake of DM and CP. A study by Merkel et al,. (1999), also showed that increased DM intake as a result of protein supplementation of diets with low roughage quality, such as rice straw and para grass this is due to the fact that a higher intake of available CP from cassava leaves presumably supports rumen microbial activity and significantly improve intake of the grass hay.

All the experimental goats showed good growth performance with continuous rate throughout the experimental period (figure 2) which indicates that all the experimental diets had nutrient content above the threshold level for maintenance requirement of goats. There was no significant differences ($p>0.05$) in mean initial live weight of goats among the dietary treatment groups. At the end of the feeding trial, goats fed *Ziziphus-spinachresti* supplemented diet had higher weight compared with those fed grass hay only. In general, all the experimental goats showed good growth performances throughout the experimental period (Figure 2).



Inwt=experiment animals initial weight of

Figure 2 Mean live weght (kg) changes of goats fed different levels of Ziziphusspinachresti leaves and natural pasture grass hay diets.

There was a significant difference ($p<0.05$) between the experimental diets containing no *Ziziphus-spinachresti* leaves and those containing *Ziziphus-spinachresti* leaves in weight gain of goats in this study. There was no significant difference ($P>0.05$) in average weight gain for goats in control group (31.4 g/day) and Zsc-25 (46g/day) which are supplemented with 0% and 25% *Ziziphus-spinachresti* leaves respectively (Table 2). However significant difference ($P<0.05$) was observed in goats among the other three groups (T3, T4, and T5) which are supplemented with 50%,75% and 100% (*Ziziphu-sspinachresti alone)* in weight gain compared with the control group fed grass hay only.

Daily weight gain of goats increased from 31.4g/day when no *Ziziphus-spinachresti* leaf was supplemented, up to 190 g/day when the highest level of *Ziziphus-spinachresti* was fed, but did not show any significant difference ($P>0.05$) between the two diets Zsc-0 (grass hay only) and Zsc-25 (25% *Ziziphus-spinachresti* leaf) or between the two diets Zsc-50 and Zsc-75 (Table 5). In general, the result of this study indicate that daily weight gain increased significantly ($P<0.05$) with increasing levels of *Ziziphus-spinachresti* leaf at 50%,75% and 100% *(Ziziphus-spinachresti alone)* compared to the treatment diets with 25% *Ziziphusspina-chresti* leaf and the diet with no *Ziziphus-spinachresti* leaf. Similarly, the feed Conversion ratio tended to improve with the addition of *Ziziphus-spina chresti* and the pattern of the response matched the live weight responses, that is the feed conversion ratio increased significantly ($P<0.05$) with increasing levels of *Ziziphus-spinachresti* leaf supplementation (Table 6).

Table 6.Effect *of Ziziphus-spinachresti* leaf supplement on growth, feed intake, average daily weight gain and feed conversion (mean ± SE).

Parameters	Experimental diets					
	T1	T2	T3	T4	T5	S.L /p
Initial weight (kg)	20.3±0.28[a]	20.4 ±0.25[a]	20.6±0.42[a]	20.5±0.39[a]	20.5±0.21	n.s
Final weight (kg)	23.1±0.99[a]	24.6±0.25[a]	29.3± 0.5[ab]	30.1±1.03[ab]	37±1.98[c]	*
Weight gain(kg)	2.8±0.22[a]	4.2± 0.03[a]	8.66± 0.04[ab]	9.56±0.25[ab]	16.46±0.31[c *]	*
Daily weight gain (g/day)	31.4 ±.04[b]	46. 7 ± 0.01[b]	90 ±0.01[ab]	110 ±0.04[ab]	190±0.05[c]	*
Feed intake (g/head/d)	440±0.58[a]	592±0.41[b]	607 ±0 .4[b]	614±0.41[b]	636±0.45[b]	**
Feed conversion ratio	10.76±1.61[a]	12.96±2.3[a]	7.1± 0.37[ab]	5.76± 0.27[ab]	3.54±0.12[c]	**
Feed conversion efficiency	0.08[a]	0.087[a]	0.17[b]	0.2[b]	0.33[ab]	**

[a, ab,b,c] means with a row with different superscripts differ significantly at p<0.05 where T: Treatment

ns=non significant * =p<o.o5 **=p<o.o1

Live weight gain

In the body weight gain experimental trial of this result showed that the goats fed on *Z. spina-christi* leaf supplement at different level had a higher daily weight gain than the control goats fed on grass without *Z.- spinachristi* leaf, but only the diet with 50%, 75% and 100% (*Z.- spinachrsti* leafs alone) fed groups was significantly different in daily weight gain in contract to the control groups. This could be a result of the fact that the CP intake was higher for those supplemented diets than for the diet with *natural grass* hay alone.

Increasing the level of *Z- spinachristi* leaves from 25 to 50% DM in the treatment diets significantly (P<0.05) increased the daily weight gain of the goats, from 46.7g to 90 g/day. This is in line with previous results showing that the Afar breed ram improved their weight gain from 60.7g to 90.47g/day when supplemented with Z. *spina-christ* level increased from 0 to 200g/head/day (Tesfay Hagos *et al*., 2015). The daily body weight gain of

goats supplemented with the minimum level of *Ziziphus* (25% DM) reported in this study (46.7g/day) was higher than the report of Bruh Weldemariam et al. (2014). who reported daily weight gain of, 23.8 g/day on Abergelle goat and the report of Axum ARC progress report (2012) which shows daily gain of , 30.3 g/day on Tigray highland small ruminants supplemented with *Ziziphus* dried leaf. Similarly the weight gain at 50%,75% and 100% *Z.- spinachristi* leaf supplementation in the current study is higher than the value (79.1 and 110.1g/day) reported by Feleke Gebregiorgis etal. (2011) . In sheep fed a basal diet of Rhodes grass hay supplemented with 300 and 400g of dried Moringa stenopetala leafs respectively. The average daily gain of 90 to 190 g/d which have significantly different and observed in this study was higher than that reported by Johnson et al. (2010) whose findings indicated average daily gain of 49.61 g and 81.86 g in goats fed forages and grains, respectively. The significantly ($p<0.05$) higher final body weight (29.3-37kg) exhibited by goats fed above 50% *Ziziphus* dried leaf supplementation was within the range of 25.40 to 49.50 kg as reported by Wildeus et al.(2007) in Boer goats fed grasses and alfalfa based diet.

4. 3. Relation between feed intake and bodyweight change

Results of mean daily DM and nutrient intake of different natural pasture grass hay-*Ziziphus-spina chresti* mixtures fed to the experimental goats are given in (Table6) The DM intake of all natural pasture grass hay and *Ziziphus- spinachrest i*mixtures were significantly higher ($P<0.05$) than the control diet (natural pasture grass hay only). However, there was no significant ($P>0.05$) difference among 25-75% grass hay-*Ziziphus-spina chresti* mixtures, reflecting that increasing the inclusion rate of *Ziziphus-spina chresti* until 75% did not significantly improve the DM intake of the goats however feeding 100%(*Ziziphus- spinachresti* alone) significantly increase DM intake of goats.

The CP intake of the diet mixed with 25-75% of *Ziziphus-spinachresti* was significantly ($P<0.05$) very much higher than the control diet. The lowest CP intake was observed in the grass hay alone (control) diet. The CP intake increased as the proportion of *Ziziphus-spinachresti* in the diet increased but there was no significant difference between offering 75 and 100% *Ziziphus-spina chresti* leaves. Significant difference ($P>0.05$) was seen in the NDF intake among the diets containing different level of *Ziziphus-spina chresti* leave

sand the grass hay only. The ADL, ADF and NDF intakes were lower (P<0.05) in the diet containing 75 and 100% *Ziziphus- spinachresti* leaves.

The cp intake increases as the proportion of *Ziziphus-spina chresti* leaves increases. The ash intake was highest insole grass hay (T5) than the control group.

Table 7. Mean daily DM of goats fed natural pasture grass hay mixed with different levels of *Ziziphus- chresti* leaves

Experimental feeds	Daily DM and nutrient intakes (g/head/day)						
	Total DM	OM	ASH	CP	NDF	ADF	ADL
Natural grass hay alone (T1)	392.1[a]	353[b]	39.12.	25.95[c]	298. 6	254.52	107.68
Grass hay-25% *ziziphus* (T2)	526.9[a]	350.	55.95	57.43	333.3	271..15	111.77
Grass hay-50% *ziziphus*(T3)	540.27	348.05	60.71	81.35	273.77	215.8	87.6
Grass hay-75% *ziziphus*(T4)	570.53	345.2	67.63	109.62	213.65	156.67	61.21
100% *Ziziphus* (T5)	556.08	343.16	70.67	133.57	141.33	84.78	27.9
SE	0.02	0.03	0.04	0.01	0.02	0.02	0.01

[a, ab,b,c] means with a row with different superscripts differ significantly at p<0.05The association among nutrient intake, digestibility and daily body weight gain of experimental goats fed on natural pasture hay and supplemented with *Ziziphus chresti* leaves mixtures is presented in Table 7.

The DMI was positively and strongly associated (p<0.01) with CPI, ADFI and CP %(p<0.05). However, its correlation with DM%, FCE, ADWG, OM %, OMI, NDF%, NDFI and ADF% was positive but without significant difference (p>0.05). There was also positive and strong association between ADWG and FCE, NDF%, ADF %(p<0.01) and NDFI(p<0.05).

CPI was positively and significantly correlated with NDF%, NDFI and ADF% (p<0.05) while it has strong and positive correlation with ADFI (p<0.01). FCE was also positively and strongly correlated with NDF%, NDFI (P<0.05) and ADF (P<0.01), however its

correlation was positive with DMI, OM%, CP%, CPI AND ADFI without significant difference ($p>0.05$) (Table 8).

Table 8. Correlation between Feed intake, daily body weight gain and feed conversion efficiency in experimental goats fed on natural pasture hay and supplemented diet

	ADWG	FCE	DM	DMI	OM	OMI	CP	CPI	NDF	NDFI	ADF	ADFI
ADWG	1	.998**	.477	.712	.613	.476	.840	.824	.961**	.953*	.981**	.832
FCE		1	.434	.677	.590	.458	.817	.798	.953*	.945*	.971**	.805
DM			1	.658	.210	.613	.647	.654	.445	.517	.492	.615
DMI				1	.782	.708	.957*	.976**	.844	.851	.810	.980**
OM					1	.155	.675	.717	.746	.655	.749	.815
OMI						1	.794	.767	.572	.681	.473	.654
CP							1	.997**	.927*	.954*	.886*	.974**
CPI								1	.920*	.940*	.883*	.987**
NDF									1	.988**	.984**	.930*
NDFI									.	1	.962**	.926*
ADF											1	.910*
ADFI												1

**=P<0.01; * =p< 0.05; DMI= dry matter intake; OMI=organic matter intake; CPI=crude protein intake;; NDFI= neutral detergent fiber intake, ADF= acid detergent fiber; ADWG= average daily body weight gain; FCE=feed conversion efficiency

From the supplemented experimental groups, grass hay-25% *Z.- spinachristi* leaf mixture diet treatment groups had significantly highest (P< 0.05) feed conversion ratio than the other supplemented treatment groups. However 25% *Z.- spinachristi* leaf mixture diet had significantly lower (p < 0.05) feed conversion efficiency (ADWG/TDMI) as compared to the highest level *Z.- spinachristi* leaf supplemented group (T5). There was significant difference in (p<0.05)in their feed conversion efficiency among the supplemented treatments except T2 comparing to the control group (non supplemented group).

There was an increasing trend of FCE as the inclusion level (supplementation) of *Z.- spinachristi* increased (i.e. T1< T2< T3<T4), however significantly increased feed conversion efficiency was observed in 50-100% *Z.- spinachristi* supplemented treatment groups.

The improved feed conversion efficiency seems to be related to higher nutrient concentration of the supplement and the consequent increase in live weight gain although, there was no significant (p>0.05) difference in their feed conversion efficiency among T3 and T4 groups. The highest level of *Z.- spinachristi* leaf supplementation has resulted in significantly (p <0.05) higher feed conversion efficiency as compared to the control treatment and other supplemented group. This indicates that goats in T5 were efficient in the utilization of nutrients for their live weight gain. Similarly Abule Ebro (1994) reported that there was a linear increment of feed utilization efficiency with the level of supplementation.

Intake of DM and CP increased with increasing levels of *Z.- spinachristi* supplementation in the present study which could be due to increased consumption of *Z. spina-christi* leaf. This is consistent with the report of, Getnent Assefa, et *al* (2008). Observed increased CP intake with increasing levels of tagasaste (Chamaecytisuspalmensis) supplementation in small ruminant fed a basal diet of grass hay. Improvement in intake through dietary protein supplementation is due to an increase in N supply to the rumen microorganisms (Van Soest,1994). This could lead to an increase in microbial population and efficiency, there by facilitating the rate of breakdown of the digesta.

The low total intake found in this experiment in animals might be most likely due to the low level of CP in the grass hay. A study conducted by Foster et al. (2009) showed that

supplementation of sheep and goats fed a basal diet of grass hay with legumes improved intake of DM, OM and CP. The increase in body weight with increasing levels of moringa leaf could be due to increased total DM and CP intake (Ranjhan, 1997) indicated that a 25 kgsheep and goat requires 94-137 g CP for average daily body weight gain of 64-101g. Likewise, a 20 kg goat, which is the average initial weight of the experiment animal, requires 85 g CP to meet its nutrient requirement for growth.

According to this recommendation, CP intake of goats in treatment groups supplemented with above 25%*Ziziphusspina-christi* leaves mixture is above the requirement that needed for maintenance, that is why the average daily gain of more than 46.7g per day in the present goat breed and even 190g/day at the maximum inclusion rate of *Ziziphusspina-christi* leaves (at 100%)in the diets.This study generally showed that increasing the level of *Ziziphusspina-christi* leaves inclusion to more than 25% increased total DM and CP intake. This could be the cause of the higher live weight gain at higher inclusion rates.

The CP intake among the different treatment groups was significantly different ($p \leq 0.05$). There was an increasing trend of CP intake as the level of supplementation increases, the highest being in T5 and the lowest in T1. The increased CP intake with the inclusion rate of *Ziziphusspina-christi leaves* supplementation level might be due to the increased total DMI and higher CP content of the *ziphus-spinachristi* than the basal diet. The CP intake of the experiment was comparable with the value reported by TesfayTsegaye (2007) on Afar rams fed on teff straw basal diet supplemented with concentrate mixtures, but lower than the CP intake reported by Bonsi et al. (1996) on sheep with teff straw basal diet supplemented with cotton seed cake.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

The results of this study clearly show that supplementation of *Ziziphus -spinachristi* leaves in the diet of goats has significantly improved feed intake and growth performance. The results indicated that the CP and ash content of the diet increased as the proportion of *Ziziphus- spinachristi* leave in the diet increased. The NDF, ADF and ADL contents were lower in *Ziziphus- spinachristi* than natural grass hay. The average daily weight gain and feed intake was significantly higher in animals fed a diet containing above 50% DM *Ziziphus- spina-christi* leaves supplementation as compared to the natural pastu*re* hay alone diet. Generally, the results of the present study showed that supplementation of goats with above 50% level of dried *Ziziphus- spinachristi* leaf in their diet significantly increased feed intake and body weight gain by improving feed conversion. Therefore, supplementation with *Ziziphus- spinachristi* leaves is a viable option to significantly improve the production and productivity of goats under smallholder farmer conditions as a supplement to low quality feed which is an evergreen tree and usually available in arid and semi-arid rangeland.

Based on the above conclusion the following recommendations are forwarded:

- To increase the validity of on-farm feeding trial, well planned on station study trial should be conducted on goats supplemented with different level of *Z.- spinachristi* leaf to predict the biological and economical significance of feeding *Z. spinachristi* for yearling goat
- Meat quality and carcass characteristics of goats supplemented *with Z-. spinachristi* leaf under feed lot condition in Kallu districts should be evaluated.
- Farmers in Kallu district which are involved in small scale goat production should be oriented about the significance of *Z.- spinachristi* leaf supplementation to low quality feed on improving growth performance of goats specially at dry season.

7. REFERENCES

Abdulrazak SA., Njuguna EG.andKarau P. 2005 .The effect of supplementing Rhodes grass (*Chlorisgayana*) hay with *Acacia tortilis* leaves and pods mixture on intake, digestibility and growth performance of goats. Livestock Research for Rural Development.17 (34).

AbebawNega, 2007. Effects of supplementation with rice bran, noug seed (*Guizotiaabyssinica*)cake and their mixtures on feed utilization and live weight change ofFarta sheep. MSc Thesis, HaramayaUniversty, Haremay, Ethiopia.

Abule Ebro, 1994. Performance of crossbred calves fed on teff (*Eragrostisteff*) straw supplemented with graded levels of cowpea (*vignaunguculata*) and *Dolochos lablab* (*lablab perpureus*) hay. MSc Thesis presented to the school of Graduate Studies of Alemaya University of Agriculture, Alemaya, Ethiopia, 41p.

AdugnaTolera, 2007. Feed Resources For producing export quality meat and livestock in

Ethiopia.

AdugnaTolera, Merkel RC, Goetsch AL, Sahlu T, Negesse T (2000) Nutritional constraints and future prospects for goat production in East Africa, pp. 43–57. *In* Merkel RC, Abebe Faculty of Agriculture.UbonRatchathaniUniversity,Thailand, pp. 165–186.

AlemDida, 2014. Substitution of concentrate mix with graded levels of dried moringa (*Moringastenopetala*) leaf meal on feed intake, digestibility, live weight change andcarcass characteristics of Arsi-bale sheep. MSc Thesis, HaramayaUniversty,Haremay, Ethiopia.

AlemuYami., and R.C.Merkel ,2008. *Sheep and goat production handbook for Ethiopia*.Ethiopian Seep and Goat production improvement program, Addis Ababa, Ethiopia.

Allen M. S. 1996. Physical constraints on voluntary intake of forages by ruminants. J. Anim. Sci. 74:3063-3075.

AmhaSebsibe, 2008. Sheep and goat meat characteristics and quality. pp. 323-338.*In:*

Aregheore E. M., C.O.C. Chibanga and N.C.J. Lungu, 1992. Effects of plan ofnutrition on body weight and birth weight of pregnant Gwambe valley goats in Zambia.Small Rumi. Res. 9: 201-208.

AschalewTsegahune, Sisay Lemma, AmehaSebsbie, AbebeMekoya and ZinashSelishi,2000. National Goat Research Strategies in Ethiopia pp1-5 In:

Assefa G,Kijora C., Kehaliew A., Bediye S., Peters K.J. 2008. Evaluation of tagasaste (Chamaecytisuspalmensis) forage as a substitute for concentrate in diets of sheep. Livestock Science, 114, 296–304.

Ayele Solomon, Assegid W, Jabbar M.A., Ahmed M.M, Hurissa B .2003. Livestock marketing in Ethiopia: a review of structure, performance and development initiatives. Socio-economics and policy research working paper 52. International Livestock Research Institute. Nairobi, Kenya. 35 pp.

Belay Derbaw, Getachew E., Tessema Zewdu andAdugnaTolera. (2014):Comparison of Nutritive Value of Alfalfa, Rhodes Hay, Cynodon Pasture and Linseed Cake –Maize Mixture at Hawassa College of Agriculture, Ethiopia *Acad. J. Nutr*., 3 (2): 19-21, 2014.

Bonsi M.L.K., Tuah A.K., Osuji P.O., Nsahlai V.I and Umunna N.N. 1996. The effect of protein supplement sources or supply pattern on the intake, digestibility, rumen kinetics, nitrogen utilization and growth of Ethiopian Menze sheep fed teff straw. *Animal Feed Science and Technology*, **64**: 11-25.

BruhWeldemariam, Solomon M, Berhan T. 2014. Supplementation of Ziziphusspina-christi, Sterculiaafricana and Terminaliabrownii to Abergelle kids fed hay: effects on feed intake, digestibility and post-weaning growth. Livest. Res. Rural Dev. 26:9.

Cheeke P.R. 1999. *Applied Animal Nutrition*, 2nd Edition, Prentic Hall Upper Saddle RiverPublishing Company, New York. USA.

CSA , 2010. Ethiopian Agricultural Sample Survey: Report on Cropand Livestock product utilization, Result at country level. Central Statistics Agency,Addis Ababa, Ethiopia, 7(468): 11-27.

CSA, 2016.Agricultural sample survey report on livestock and livestock characteristics, volume II, Addis Ababa, Ethiopia.

Devendra C. (1978). World Rev. Anim. Prod. 14: 9.

Devendra C. 1983. Digestive Efficiency of Goats.*World Review Animal Production,*14: 1922.

Devendra C. andBurns M, 1983. *Goat production in the Tropics.*Secon Edition. Commonwealth Agricultural Bureau.Farnham Royal, Slough SL 3BN, UK.183pp.

EARO (Ethiopian Agricultural Research Organization). 2000. National Small RuminantsResearch Strategy Document. EARO, Addis Ababa, Ethiopia.

Elamin M E. and Babiker M A. 2000. The composition and degradation in the rumen of goats of different parts of different forage trees in Gezira(Sudan), U. of K. J Agric. Sci. 8(1).: 120 – 133.

ESGPIP (Ethiopian Sheep and Goat productivity Improvement Program), 2008. A PracticalGuide on Village-Based Sheep and Goat Cooperative Breeding schemes. ESGPIP,Addis.

Fagg C.W. and Stewart J.L. 1994. The value of Acacia and Prosopis in arid and semi-arid environments. J. Arid Environments, 27: 3-25.

FARM-Africa, 1996.Goat Types of Ethiopia and Eritrea.Physical description andmanagement systems.Published jointly by FARM-Africa, London, UK and InternationalLivestock Research Institute, Nairobi, Kenya.

FelekeGebregiorgis, Tegene, N., Ajebu N. 2013. Feed intake and utilization in sheep fed graded levels of dried moringa (Moringastenopetala) leaf as a supplement to Rhodes grass hay. Trop Anim Health Prod., 41.

FelekechLemecha, Jamroen T, Sayan T. and Somkiert P .2013. Survey of goat feed sources and supplements in central rift valley of Ethiopia. Kasetsart Journal Natural Science 47: 712 – 719.

Food and Agricultural Organization (FAO), 2002. Contribution to the sustainable livelihoods and development: realizingsustainable breeding programmes in livestock production. recommendations developed for and finalized for wide distribution by a symposium conducted jointly by the world congress on genetics applied to livestock production the Food and Agricultural Organization of the United Nations, France. Rebel.

Foster J, Adesogan A, Carter J, Blount A, Myer R. and Phata K. 2009. Intake, digestibility and N retention by sheep supplemented with watm-season legume hays or soybean meal. J. Animal Sci., 87: 2891–2898.

GetnetAssefa ,Kijora C., Kehaliew A., Bediye S., Peters K.J. 2008. Evaluation of tagasaste (Chamaecytisuspalmensis) forage as a substitute for concentrate in diets of sheep. Livestock Science, 114, 296–304.

GetahunLema, 2008. Productive and economic performance of small ruminant production in production system of the highlands of Ethiopia.PhD dissertation.University of Hohenheim, Stuttgart, Hoheinheim, Germany.

Giger S. and Sauvant D. 1991. Evaluation and utilization of concentrates in goats. In:Morand-Fehr. P ed., Goat nutrition, EAAP Publication No.46, Pudoc, Wageningen, theNetherlands. pp. 172-180.

GirmaHailu, 2013. Effect of different proportion of malted oat grain and noug seed cakesupplementation on digestibility and performance of Arsi-Bale sheep fed grass haybasal diet. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Goacher WE.and Church D C. 1970. Taste response in ruminant's reactions in pigmy goats,normal goats, sheep and cattle to sucrose and sodium chloride. J. AnimalSci. 31: 364-372.

Guinand Y. and Dechassa Lemessa (2002). Famine Food Guide Ethiopia: (http://www.africa.upenn.edu/faminefood/category1.htm: accessed on 27 June 2004).

HabtomNegussie, 2012. Effects of substituting basal diet of natural pasture grass hay withurea treated maize stover on feed intake, milk yield and milk composition ofHolstein Friesian cows. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

IBC (Institute of Biodiversity Conservation), 2004. The State of Ethiopia's Farm animalGenetic Resources: Country Report. A Contribution to the First Report on the State of theWorld's Animal Genetic Resources. IBC, May 2004. Addis Ababa, Ethiopia

Ikhimioya1 O A, Isah1 UJ , Ikhatua and Bamikole MA .2005. Rumen Degradability of Dry Matter and Crude Protein in Tree Leaves and Crop Residues of Humid Nigeria. Pakistan J. Nutr.4 :313-320.

Johnson C, Doyle S. and Long R. 2010. Effect of feeding system on meat goat growth performance and carcass traits. Sheep Goat Res. J. 25:78-82.

Kallu District office Of Agriculutral (2014),Data On Rain Fall ,Minimum And Maximum Temperature ,Population Of Small ruminant

Kiwuwa G. 1992. Breeding Strategies for Small Ruminant Productivity in Africa.Web Site http://www.fao.org/docrep/009/ah221e/AH221E11.htm.

Lebbie S. 2004. Goats under household conditions. Small Ruminant Res. 51: 131- 136

Lebbie S. and Manzini A. 1989.The productivity of indigenous goats undertraditional management in Swaziland. In: Wilson R.T. and Azeb M. (eds). African smallruminant research and development. Proceedings of a Conference held at Bamenda,Cameroon. pp. 39-50.

Louca A. and Hancock J. 1977.Genotype by environment interactions for post weaninggrowth in the Damascus breed of goat.*J. Anim. Sci.* 44: 927-931.

Lu C. andPotchobia J. 1990. Feed intake and weight gain of growing goats feddiets of various energy and protein levels. *J. Anim. Sci.* 68: 1751-1759.

MataworkKilkias, 2016. Review on Small Ruminant Production, Marketing and Constraints in Ethiopia. Adv. Li. Sci. 48.

Matiwos Solomon, 2007. The effect of different levels of cottonseed meal supplementation onfeed intake, digestibility, live weight changes, and carcass parameters of Sidamagoats.MSc Thesis, Haramay University, Haramaya.

Mupangwa .1997 .Rumen dry matter degradation of different parts of Ziziphusspina Christ men Degr

McDonald , Edwards R, Greenhalgh J. and Morgan C. 2002. *Animal Nutrition*, 6thEdition. Pearson Educational Limited, Edinburgh, Great Britain.

McDonald P, Edwards R, Greenhalgh J. and Morgan C. 2010. Animal Nutrition, 6th ed., Prentice Hall, London. pp. 464-544.

McDonald P, Edwards R, Greenhalgh J. and Morgan C. 20o2.Animal Nutrition, 6th ed., (Prentice Hall, USA).

Mohammed Ismail, 2005. Effect of feeding different levels of khat (*cathaedulis*) leftover onfeed intake and growth performance of goats fed on sorghum stover. MSc Thesis,Haramaya University, Haramaya, Ethiopia.

Morand-Fehr P, Sauvant D. and BrunBellut J. 1987. Recommended allowances forgoats. Bull. Tech. CRVZ.Thesis INRA. 70: 213-222.

Mowlem A, Oldham D. and Nash S. 1985.Effect of concentrate allowance on *ad libitum* hay consumption by lactating British Saanen goats. Ann. Zootech. 34: 474.

MulukenZerihun, 2006. Goat husbandry practices and productive performances in Sekotaworeda of Amhara region.MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Nahand M K, Doust-Nobar RS, Maheri-Sis N. and Mahmoudi S. 2012. Determination of feed value of cherry, apricot and almond tree leaves in ruminant using in situ method . Open Vet. J. 2: 83-87.

Njidda A. and Olatunji E. 2012. Chemical compostion ,antinutritive substance and in situ Digestion kinetics of four Ziziphus species leaves used as fodder for ruminants in semi Arid Zones of Nigeria. J. N. Sci. Res. 2012.

Norton BW.1998. The nutritive value of tree 31.legumes. In: Gutteridge, R.C. Shelton, H.M. (Eds.), Forage trees legumes in Tropical Agriculture. Tropical Grassland Society of Australia Inc. St Lucia Queensland.

Nurfeta A. 2010. Feed intake, digestibility, nitrogen utilization and body weight change of sheep consuming wheat straw supplemented with local agricultural and agro-industrial by-products. Trop. Anim. Heal. Pro. 42:815–824.

Orwaetal,.Agroforestry Database 4.0 pag3-5

Palgrave K.1983. Trees of Southern Africa.2nd edition. Struik Publishers. Cape Town.

RanjanSK.1997. Animal nutrition in the tropics.Vikas publishing house Pvt. Ltd., New Delhi, India. 365p.

Rittner U. and Reed J.1992.Phenolics and *in vitro* degradability of protein and fiber in West African browse", J.Sci.Food and Agr.58: 21–28.

Romney DL. and Gill M. 2000. Intake of Forages. pp. 43-57. *In*: Givens, D. I., E. Owen,F.E. Oxford, and H.M. Omed. (eds.), *Forage Evaluation in Ruminant Animals*,CABI, New York, USA.

SAS (Statistical Analysis System) , 1998). SAS/STAT Guide to Personal Computers, Version 7.Statistical Analysis System Institute. Inc., NC. North Carolina, USA.

Seid Mohammed, 2010. Feedlot performance, carcass and skin quality evaluation of Arsi-Bale goats and their 50% crosses with boer goats. MSC Thesis Haramaya University,Haramaya, Ethiopia.

SeyoumBediye and ZinashSileshi, 1989. The composition of Ethiopian feedstuffs, Research report No. 6. Institute of agriculture research (IAR), Addis Ababa,Ethiopia. 33p.

SeyoumBediye and ZinashSileshi. 1989. The composition of Ethiopian feeds. *Holetta Agricultural Research Center,* 6:17-24.

Shahjalal M, Bishwas A. Tareque M. and Hoki M. 2000. Growth and carcasscharacteristics of goats given diets varying protein concentration and feeding level.Asian- Aus. J. Anim. Sci.13: 613-618.

ShamseldeinH , Ahmed, Shadia A.2014. Omer Rumen Degradation and Nutritive Value of Fruit Flesh Seed Cake, Leaves and Green Shoots of Sidder (ZiziphusSpina-Christi) Trees.International Journal of Novel Research in Civil Structural and Earth Sciences.1 (1) 46-52.

SimretBetsha, 2005. Supplementation of graded levels of peanut cake and wheat branmixture on nutrient utilization and carcass parameters of Somali goats.An M.Sc. ThesisPresented to the School of Graduate Studies of Alemaya University of Agriculture,Alemaya, Ethiopia. 60p.

Solomon Gezaw, AzageTegegne, Berhanu G, Hoekstra D. 2010. Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement. Working Paper No. 23, International Livestock Research Institute http://cgspace.cgiar.org/bitstream/handle/10568/2238/IPMS_Working_Paper_23.pdf?sequence=1.

Solomon Melakuo ,Teferi A. and Lisanework N .2010. Chemical composition, in vitro dry matter digestibility and in sacco degradability of selected browse species used as animal feeds under semi-arid conditions in Northern Ethiopia. Agroforest Syst. 80:173-184.

Solomon Mogus, 1995. The effect of processing methods of oil seed cakes in Ethiopia on their nutritive value: *In vitro* N degradability and N- Metabolism in growing sheep fed abasal diet of maize stover. PhD. Thesis University of Bonn, Germany.

TibebuManay, AdugnaTolera A.Zewdu T, 2009. Feed intake, digestibility and body weight gain of sheep fed Napier grass mixed with different levels of *Sesbaniasesban*. Livest. Sci. 122 : 24-29.

TeferiAregawi, Solomon Melaku and LisaneworkNigatu, 2008.Management and utilization of browse species as livestock feed in semi-arid district of North Ethiopia

TesfayHagos, 2007. Supplementation of Afar rams with graded levels of mixtures of protein and energy sources: effects on feed intake, digestibility, live weight and carcass parameters. MSc Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Ethiopia.

Tesfaye Hagos, Teshale T, Dawit G. and Yohannes T. 2015. On farm evaluation of the growth and economic benefit of afar breed rams supplemented with different protein sources: The case of Raya-Alamata District. Afr. J. Agric. Res.10: 2248-2253.

Tesfaye Tsegaye, 2009. Characterization of goat production systems and on- farm evaluationof the growth performance of grazing goats supplemented with different proteinsources in Metemaworeda. MSc Thesis, Haramaya University Haramaya, Ethiopia.

Tessema Zewodu, AkliluAgidie, AmehaSebsibe , 2003. Assessment of the livestock production system, available feed resource and marketing situation in BelesaWoreda: A case study in drought prone of Amahara region, pp. 165–175. In ESAP, (eds.). Proceedings of the 10th Annual Conference of the Ethiopian Society of Animal Production. 22–24 August 2003. Addis Ababa, Ethiopia.

TsedekeKocho, 2007. Production and marketing systems of sheep and goats in Alaba,Southern Ethiopia. An MSc Thesis Presented to the School of Graduate Studies of HawasaUniversity college of agriculture,Hawasa.. 120pp.

Van Soest P J and Robertson J B. 1985. Analysis of forages and fibrous foods: A laboratory manual for Animal Science 613. Department of Animal Science, Cornell University, Ithaca, New York, USA.202 pp.

Van Soest PJ .1994. Nutritional Ecology of Ruminants.2nd ed. Cornell University Presss, London.Pp. 476.

Vanes A.1997. Evaluation of feeds overall appreciation. P. 15-24.

Workneh A, Rischkowsky B, King J M. and Bruns E. 2003. Crossbreds did not create more net benefits than indigenous goats in Ethiopian smallholdings. Agricultural Systems, 76: 1137-1156.

APPENDIX

Appendix Table 1. Summary of ANOVA for body weight change of local goat fed natural pasture grass hay and supplemented different levels of *Ziziphusspina-christi* leaf

Parameter	TDF	TMS	TSS	FR	P>F	SEM	Mean	SL/p
Initial weight (kg	24	0.506	12.400	0.939	0.232	0.450	20.68	Ns
Final weight	24	6.230	124	6.230	0.006	1.579	29.22	***
Weight gain	24	6.000	68.222	3.650	0.030	1.003	8.54	**
Daily weight gain (g/day)	24	641.872	6532.005	2.563	0.000	1.202	94.875	***
Feed intake (g/head/d)	24	1549.52	39002.01	0874	0.04	1224	577.8	**
Feed conversion ratio	24	5.01	41.21	1.34	0.061	1.001	8.024	Ns
Feed conversion efficiency	24	0.0034	0.0432	1.12	0.021	0.0001	0.1734	**

***= ($p<0.01$); **= ($p<0.05$); ANOVA: analysis of variance, TMS= total mean square treatment, FR= F ratio of treatment, Prob= probability of treatment, SEM= standard error of mean, TDF= total degree of freedom, SL=significant level, TSS= total sum of square

Appendix Table 2. Monthly sun shine hour

Year	Jun	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1995	9.7	7.9	7.8	7.4	8.9	8.9	6.5	6.9	7	8	9.4	8.2
1996	7	9.5	7.3	8.6	7.7	7.6	6.3	6.6	6.8	9.2	8.2	9.1
1997	6.4	10.3	7.2	7.7	9.4	7.2	7.4	6.8	7.2	7.2	7.3	9.8
1998	5.9	6.6	7	8.6	8.5	8.9	6.2	5.3	6.6	6.5	9.6	10.2
1999	7.6	xx	8.1	10.2	9.2	7.8	5.9	7.2	7.1	6.1	9.8	9.2
2000	10.1	10.6	9.6	7.5	9.1	8.7	7	5.8	6.6	7.2	8.4	8.3
2001	7	9.3	5.5	9.7	8.9	Xx	xx	5.3	7.4	7.5	8.8	9.5
2002	6.9	9.4	7.4	9.2	8.9	7.6	7.1	7.3	6.2	8.7	12.6	6
2003	7.8	8.7	8.1	7.6	10.3	7.2	5.7	5.7	6.5	9.2	9.2	9
2004	7.9	8.4	8.6	6.8	10	6.3	6.7	7.2	6.7	8.1	9.6	8.1
2005	7	10	8.3	8.1	8.2	8.4	6.7	7.5	7.2	8.2	9.5	10
2006	9.2	8.1	7.7	7.7	9.5	7.9	6.3	6.2	6.8	7.9	8.5	6.9
2007	6.1	7.4	8.7	8.5	8.7	6.3	5.3	7.1	6.8	8.9	8.8	10.2
2008	8.9	10	10.7	9.2	8.7	8.6	6.5	6.7	7	7.6	7.9	9.4
2009	8.2	8.4	8.7	9.3	9.8	9.1	5.9	6.5	7.6	7.4	10	6.6
2010	8.4	6.3	5.9	6.7	7	7.1	6.8	5.7	7.3	8.6	9.2	7.7
2011	7.7	9.5	7.9	8.9	7.7	8.5	6.8	6.8	7.5	9.3	6.8	10
2012	9.2	10.7	9.2	7.7	8.7	7.2	5.3	5.4	6.7	9.4	9.7	9.4

Appendix Table 3. Average maximum temperature ^{o}C

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	De
1996	2	26.7	25.8	26.5	26.7	28.8	28.1	26.6	26.7	26.4	24.3	24.1
1997	23.8	25.9	27.1	26.8	29	29	28	27	27.4	25.9	24.8	24.7
1998	23.7	24.5	26.1	28.5	28.4	31.7	27.4	26.4	26.6	25.8	25.2	25.1
1999	24.4	27.6	26.7	29.3	30.6	31.4	26.9	26.6	26	24.2	24.3	23.8
2000	25.5	26.9	28.1	28	28.5	31	28.2	26.6	26	25.1	24.3	23.8
2001	23.2	26.1	25.4	27.8	29.3	30.3	27.6	26.5	26.2	26.2	25	25.4
2002	24	26.5	27.2	27.8	30.5	31.3	30	27.8	26	26.7	26.1	24.2
2003	24.1	27.1	27.5	27.7	30.2	30.7	28.1	26.4	26.3	26.1	25.8	24.5
2004	26.1	25.5	27.2	26.5	30.1	29.9	28.7	27.5	26.4	25.2	25.5	24.9
2005	25	28.1	28.1	28.1	27.8	30.7	27.8	27.3	26.9	26	25.8	-
2006	25	28.1	28.1	28.1	27.8	30.7	27.8	27.3	26.9	26	25.8	
2007	25.6	27.2	27.1	26.3	29	31.4	28	27.2	26.5	26.7	25.4	24.7
2008	23.6	26.3	28.2	27.6	30.4	30.4	27.1	27.3	27.3	26.2	25.3	25.5
2009	26.3	26.5	29.3	29	30.2	31	29.2	27.3	27.2	26.3	24.8	25.1
2010	25.2	27.1	28.6	29.3	28.4	32	28.2	27.5	28	26.2	26.7	24.8
2011	25.6	26.5	26.6	28.5	29.2	31.5	28.6	29.2	27	27	25.9	24.3
2012	24.8	27.1	26.4	29.5	28.4	30.1	28	26.7	27.1	26.3	24.7	25.7
2013	26.4	27.6	28.3	26.9	28.6	30.2	28.2	27.5	27.6	26.7	26.9	26.1
2014	26.3	27.5	28.5	29.2	29.7	30.8	28.2	26.4	27.4	26.1	25.8	24.8

Appendix Table 4. Average minimum temperature of Kombolcha metrology station

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	De

1996	12.4	10.9	13.5	13.7	13.9	14.8	15.2	14.9	14.3	9.5	8.8	8.3
1997	11.1	8.6	13.4	13.5	13.3	14.6	14.9	14.1	13	11.5	11	8.4
1998	13.1	13.8	14.1	14.5	14	15.1	15.1	15.1	13.6	11.7	7.1	5.9
1999	9.1	8.2	12.8	12.2	14.3	15	15	14.6	14.1	12	6.8	8
2000	8.5	8.1	11.3	13.5	14.4	14.6	14.5	14	13.3	11.8	8.9	8.5
2001	8.6	9	13.1	12.8	14.3	15.7	14.4	15	12.7	11.4	8.2	8.1
2002	11.4	10.8	13.2	13.5	14.3	15.3	15.9	15.2	14.4	10.4	8.2	12.6
2003	10.7	11.9	13.3	14.1	14.2	15	15	15.4	14.6	9.4	8.5	8.1
2004	14.5	10.5	11.2	14.4	13	13.5	14.8	14.6	17.9	9.5	8.6	10.3
2005	13.6	10	13.3	13.8	15.1	15.1	15.2	15.2	14.4	9.7	8.1	5.7
2006	9.6	12.5	12.8	13.9	13.9	14.8	15.3	15.2	14	11.8	10.1	12.1
2007	11.4	12.5	12	14	14.5	16.5	15.4	15.1	14.4	9.8	8.6	6.5
2008	9.2	9	8.9	12.9	15.4	15.7	15.8	15.1	14.3	11.3	9.4	8
2009	10	11	12.2	13.5	12.5	16.2	15.4	15.4	14	11.5	8.6	12.1
2010	10.4	13.6	13.2	15.1	15.5	16	15.7	15.5	14.5	11.6	9.3	9.5
2011	11	9.8	11.7	13.8	15.1	15.4	15.7	15.3	13.7	10.9	11.9	8.4
2012	8.8	7.6	10.5	13.8	13.9	15.2	15.4	15.2	14.5	9.8	9.6	9.4
2013	10.1	10	14.2	15.3	15.3	16.8	16	15.4	14.1	12	10.7	7.5

Annex table 5. Land use practice

Farm land	27454
Land covered by bush	50842
For grazing	937
For construction	3932
Land covered by water bodies	232
Land covered by wet land	400
Bare land	3786
Total	87,523

Source: KalluWoreda agricultural office,(2007)

Annex 6. Questionnaire

1. Name of house holds

2. Sex

A Female B) Male

3. Age

A) Below 20 B) 20-35 C) 35-45 D) 45-60 E above 60

4. Total land holding size in Ha

A) Less than 0.25 B) 0.25- 0.5 C) 0.5-1ha D) above 1 ha

5. Numbers of livestock owned

A) Oxen B) cow C) heifer D) bull E) calves F) sheep G) goats H) donkey

I) camel J) chicken K) bee

6. Purpose of keeping goats

A) For consumption B) market /cash income C) insurance D) Others

7. Which type of livestock generated more income?

8. Do use zizipusspina Christi for your goats as a major feed resource?

A) Yes B) No

9. From the above question your answer is yes what is the advantage from the other feeding resources?

10. How to use zizipusspina Christi for your goat?

A) Browsing B) cut and carry C) Foliage

Appedix figure 1*Ziziphusspinachresti tree*